ECE406 **Algorithm Design and Analysis** **Winter 2020**

Course Motivation: Algorithms provide methods for solving problems, and are at the foundation of computing. It is important that practitioners in electrical and computer engineering understand how algorithms are designed, and how to analyze them for correctness and efficiency. It is important also to be able to distinguish intractable problems from ones that are tractable so one does not naively seek efficient solutions when none may exist. For cases that are intractable, it is important to know how to design approximate solutions that satisfy bounds on correctness and efficiency. Industry has long recognized the critical importance of algorithms that are correct and efficient.

Instructor: Prof. Stephen L. Smith (stephen.smith@uwaterloo.ca; Office: E5 5112).

- Office Hours: Tuesday 1-2pm (E5 5112), or as arranged otherwise.
- Please put "ECE406" at the front of your subject line for all course related email.

TAs:

- Armin Sadeghi (`a6sadegh@uwaterloo.ca`)
- Nils Wilde (`nwilde@uwaterloo.ca`)
- Shamak Dutta (`s7dutta@uwaterloo.ca`)

Office hours will be posted on LEARN.

Lectures: Mon and Fri: 11:30 - 12:50 (E7 5353)

- Lectures will not be held during reading week (Feb 17 - 21).

Course Outline: Design and analysis of efficient, correct algorithms. Advanced data structures, divide and conquer algorithms, recurrences, greedy algorithms, dynamic programming, graph algorithms, search and backtrack, inherently hard and unsolvable problems, approximation and randomized algorithms, and amortized analysis.

The following is a more detail on the material covered in the class. Note that not all sections of each chapter will be covered.

Topic	**Chapter in Text**	**Duration**
Introduction to algorithms	Chapter 0	0.5 hours
Factoring, primality, cryptography	Chapter 1	4.5 hours
Divide and conquer algorithms	Chapter 2	5 hours
Graphs, decompositions and depth-first search	Chapter 3	3 hours
Paths in graphs: Dijkstra's alg, priority queues	Chapter 4	3 hours
Greedy algorithms: MST, MP3 encoding, set cover	Chapter 5	3 hours
Dynamic Programming: Shortest paths, knapsack	Chapter 6	4 hours
Linear Programming: Network flow, simplex algorithm	Chapter 7	4 hours
Inherently hard problems: NP-completeness, reductions	Chapter 8	5 hours
Intelligent exhaustive search and approximation algorithms	Chapter 9	4 hours

Textbook: The main (and required) text for the course is

1. S. Dasgupta, C. Papadimitriou, and U. Vazirani, *Algorithms*, McGraw-Hill, 2008.

The following textbooks may also be useful for additional information on subjects:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, MIT Press, 2009

2. J. Kleinberg and E. Tardos, *Algorithm Design*, Addison Wesley, 2005.

Grading: The course will consist of assignments, a midterm, and a final exam. There will be a total of six homework assignments, given roughly once every two weeks. The grading scheme is

- Assignments: 20%
- Midterm: 30%
- Final Exam: 50%

We will be using Crowdmark for grading.

Midterm Exam: Feb 26, 17:45-19:00 (tentative), location TBD

Assignments Information and Guidlines: Assignments are given every other week, and their primary goal is to give you practice in designing and analyzing algorithms. Be sure to spend a good amount of time working on these. Assignments are graded fairly leniently, so try not too worry about grades too much, and focus on getting some practice. The following are some details:

- **There will be no extensions or late assignments accepted**. As compensation for this rather harsh rule, the assignment with least score will be dropped in calculating the assignment average. To be fair to all students, requests for extension receive the following "canned" response:

  > The course policy is that there are no extensions for assignments. As compensation, I will automatically drop your lowest assignment grade of the six.

- Assignments are submitted using Crowdmark `https://app.crowdmark.com/sign-in/waterloo`.

- Programming exercises are written in **Python 3**, and your code is to be submitted in the corresponding dropbox on LEARN.

- Assignment are to be submitted individually and must be written in your own words. You are free to collaborate with other students on assignments in order to hash out initial solution ideas. You must list these collaborators at the top of the first page of your assignment (there is no penalty for listing collaborators, but it ensures we do not falsely identify plagiarism).

- Cite all sources used in your solutions (other than the course notes or the main textbook). In submitting an assignment, you are "signing off on your work" as described in the academic integrity form at `https://uwaterloo.ca/academic-integrity/`. The penalty for a first plagiarism offence is -100% for the assignment.

General University of Waterloo Guidelines:

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. Check `http://www.uwaterloo.ca/academicintegrity/` for more information.

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, `http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm`.

When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity—check `http://www.uwaterloo.ca/academicintegrity/` to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about rules for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, `http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm`.

For typical penalties check Guidelines for the Assessment of Penalties, `http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm`.

Appeals: A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) `http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm`.

Note for Students with Disabilities: AccessAbility Services, located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the AccessAbility Services at the beginning of each academic term.